DESCRIPTION OF A NEW SPECIES OF *THAUMASTOCHELOPSIS* FROM THE CORAL SEA (CRUSTACEA: DECAPODA: NEPHROPOIDEA)

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ABSTRACT

A new species of homaridan lobster, *Thaumastochelopsis brucei* sp. nov., is described from the Coral Sea. The new species is the second in the genus and differs chiefly from the type species, *Thaumastochelopsis wardi* Bruce, 1988, in the armature of the dactylus and pollex of the major cheliped. The high degree of divergence (8.4%) between 12S rRNA sequences of *T. wardi* and *T. brucei* strongly corroborates their specific separation. A key to the extant species of Thaumastochelidae is provided.

Thaumastochelidae was established by Bate (1888) to accommodate the deep-water clawed lobster *Thaumastocheles zaleucus* (Thomson, 1873). At present, Thaumastochelidae includes three genera: the type genus *Thaumastocheles* Wood-Mason, 1874, *Thaumastochelopsis* Bruce, 1988, and the extinct *Oncopareia* Bosquet, 1854 (Ahyong, 2006). Thaumastochelids differ from members of the Nephropidae Dana, 1852, chiefly by the possession of markedly unequal first chelipeds in which the major chela bears a short, bulbous palm with long, slender fingers and in the reduced and truncate instead of well-developed abdominal pleura (Holthuis, 1974, 1991). The extant thaumastochelids further differ from nephropoids in the quadrate telson, lack of posterolateral telson spines and in the chelate fifth pereopods, characters that are yet to be determined for the extinct *Oncopareia*. Although Thaumastochelidae is monophyletic, its phylogenetic position with respect to other nephropid genera is unclear. Tshudy and Babcock (1997), studying fossil and extant genera, found that Thaumastochelidae was probably nested within and therefore synonymous with Nephropidae. Subsequent studies, however, based on morphology (Tshudy and Sorhannus, 2000; Martin and Davis, 2001; Ahyong, 2006), or combined morphological and molecular data recognised a monophyletic thaumastochelid clade (Ahyong and O'Meally, 2004). We presently recognize Thaumastochelidae pending further study of clawed lobster phylogeny.

Thaumastochelopsis was erected by Bruce (1988) to accommodate a new species, *Thaumastochelopsis wardi*, from the Coral Sea off central Queensland, Australia. Between 1995 and 2001, specimens of an unusual thaumastochelid, also from the Coral Sea off central Queensland were collected. These specimens were morphologically distinct from *T. wardi* in the armature of the dactylus and pollex of the first chelipeds, and appeared to represent an undescribed species. Moreover, the differences in major chela morphology between the two forms of *Thaumastochelopsis* directly paralleled that of two species of *Thaumastocheles*: *Thaumastocheles japonicus* Calman, 1913, and *Thaumastocheles dochmiodon* Chan and de Saint Laurent, 1999. In view of the close morphological similarity between *Thaumastochelopsis wardi* and the new form, we also compared partial 12S rRNA sequences of the two forms to test our conclusions based on morphology. We herein report on the new form as a new species: *Thaumastochelopsis brucei* sp. nov.

Materials and Methods

Molecular Protocols.—Total DNA was extracted from abdominal muscular tissue and pleopod tissue of paratypes of *T. brucei* and *T. wardi*, respectively, using QIAamp DNA Mini Kit (QIAGEN, Hilden, Germany). The tissues were washed three times with double distilled water (ddH_2O) prior to proteinase K digestion. After extraction, the DNA was eluted in 200 µl of ddH_2O. A segment of mitochondrial 12S rRNA gene was amplified by polymerase chain reaction (PCR) with the primers 12SAI (Palumbi et al., 1991) and 12SH2 (Taylor et al., 1996). The 50 µl amplification reaction mix contained 5.0 µl of DNA extract, 1X PCR buffer (QIAGEN), 0.4 µM of each primer, 200 µM of dNTPs, 2 units of Taq polymerase (QIAGEN), and ddH_2O. The cycling profile was as follows: 2.5 min at 94 °C for initial denaturation, then 32 cycles of 25 s at 94 °C, 30 s at 49 °C, 45 s at 72 °C and the final extension for 3 min at 72 °C. Prior to sequencing, PCR product was purified using QIAquick PCR purification kit (QIAGEN) according to manufacturer's instructions. 20 µl of cycle sequencing mix, containing 8 µl of ABI Prism dRhodamine terminator (Applied Biosystems, Foster City, California), 3 µl of purified PCR products, 1 µl of 3.3 µM primer, and ddH_2O, was analyzed using an ABI 3100 Genetic Analyzer (Applied Biosystems).

Morphological Protocols.—Morphological terminology pertaining to carapace grooves and spines follows Holthuis (1974). Measurements of specimens are in millimeters (mm); carapace length (cl) is measured along the dorsal midline and includes the rostrum; postorbital carapace length (pcl) is measured from the posterior margin of the orbit to the posterior margin of the carapace. Type specimens of *T. brucei* were deposited in the Australian Museum, Sydney (AM), and Queensland Museum, Brisbane (QM).

Results

Molecular Data and Sequence Comparisons.—A 403 bp nucleotide sequence of a 12S rRNA gene segment was unambiguously determined for *T. wardi* and *T. brucei* (GenBank accession nos. DQ657354 and DQ657355). The nucleotide divergence (p-distance) between the aligned sequences (405 bp) of the two species is 8.4%. We compared this value with divergences between congeneric species of three other genera of Nephropidae. These values are based on 12S rRNA gene sequences of these species from a project on Nephropidae phylogeny currently in progress (see Tshudy et al., 2005). The divergence of the corresponding 12S rRNA gene segment between *Th. dochmiodon* and *Th. japonicus* (GenBank accession nos. DQ298437 and DQ298438) is 1.0% and that between *Nephropsis serrata* Macpherson, 1993 and *Nephropsis stewarti* Wood-Mason, 1872 (GenBank accession nos. DQ298434 and DQ298435) is 6.6%. Moreover, four *Enoplometopus* species (*Enoplometopus crosnieri* Chan and Yu, 1998, *Enoplometopus occidentalis* (Randall, 1840), *Enoplometopus daumi* Holthuis, 1983 and *Enoplometopus debelius* Holthuis, 1983; GenBank accession nos. DQ298421–298424) exhibit divergence of 1.7%–10.1% (mean 6.5%). In our phylogenetic analysis of 20 species belonging to 11 homaridan genera (unpubl. data, Tshudy et al., 2005), *T. brucei* and *T. wardi* are sister taxa, corroborating our generic placement of the new species. More importantly, however, the relatively high degree of sequence divergence between *T. wardi* and *T. brucei* strongly corroborates their specific separation.

Systematics

Family Thaumastochelidae Bate, 1888
Genus *Thaumastochelopsis* Bruce, 1988
Thaumastochelopsis brucei new species

Thaumastochelopsis sp.—Ahyong and O'Meally, 2004: 687.

Type Material.—Holotype: AM P49083, male (cl 21.1 mm, pcl 14.7 mm), east of Swains Reef, Queensland, Australia, 21°59.43′S, 153°06.60′E, 199 m, trawled, FV "Seadar Bay", QLD-1256, J. Lowry and K. Dempsey, 10 Sep 1995. Paratype: QM W25868, male (cl 25.6 mm, pcl 19.3 mm), Coral Sea, 20 mi northeast of Heron Island, Queensland, 23°20′S, 152°12.50′E, 250 m, P. Duncan, 6 Jun 2001.

Diagnosis.—Rostral margins with 2 or 3 spines. Abdominal pleuron 1 with stout, ventrally directed spine adjacent to pleopod articulation; surfaces of pleura 2–5 with laterally directed spines; pleura 2–5 with lower and posterolateral margins bearing numerous stout spines. Pollex and dactylus of major and minor pereopod 1 with occlusal margins finely serrate, with teeth inclined anteriorly. Pereopod 3 merus with distal spine on upper margin.

Description.—Rostrum triangular with shallow median sulcus; apex acute; anterior half deflected ventrally; finely and sparsely setose; margins with 2 or 3 spines, inclined anterodorsally.

Carapace evenly granular over entire surface; with small supraorbital and postorbital spine; orbital fossa obsolete; pterygostomial margin faintly convex, with 5 or 6 prominent spines on margin; anterolateral angle rounded, with 4–6 small spines, meeting pterygostomial margin at obtuse angle; ventral branchiostegal margin unarmed, setose; postcervical, cervical, hepatic, and antennal grooves continuous with each other; branchiocardiac groove faintly indicated, subparallel to midline; with posterolateral marginal carina (Fig. 1).

Abdomen strongly depressed; finely granulate dorsally; lateral carinae of tergites 1–6 with tuberculate margins, those of tergites 1 or 2 partially spinous; tergites 1–5 posterior margins setose; tergite 6 with posterior margin tuberculate; pleuron 1 rudimentary, with stout, ventrally directed spine adjacent to pleopod articulation; surfaces of pleura 2–5 tuberculate with stout, laterally directed spines; pleura 2–5 with lower and posterolateral margins bearing numerous stout spines; tergite 6 with lower pleural margin rounded, tuberculate, and sparsely setose.

Telson quadrate; margins setose; sparsely granulate dorsally.

Antennular peduncle not reaching apex of scaphocerite; inner flagellum longest, 0.95 postorbital carapace length; outer flagellum thicker, setose ventrally. Antennal basicerite with distodorsal spine and 2 ventral spines anterior to pore of antennal gland. Scaphocerite triangular, with 4 or 5 spines on inner margin.

Epistome fused anteriorly with carapace; with sharp, sparsely distributed tubercles; posterior margin raised, with short sharp spines.

Eye on movable stalk; corneal region rounded, unpigmented, setose dorsally; not extending beyond antennular peduncle segment 2.

Third maxilliped with vestigial exopod.

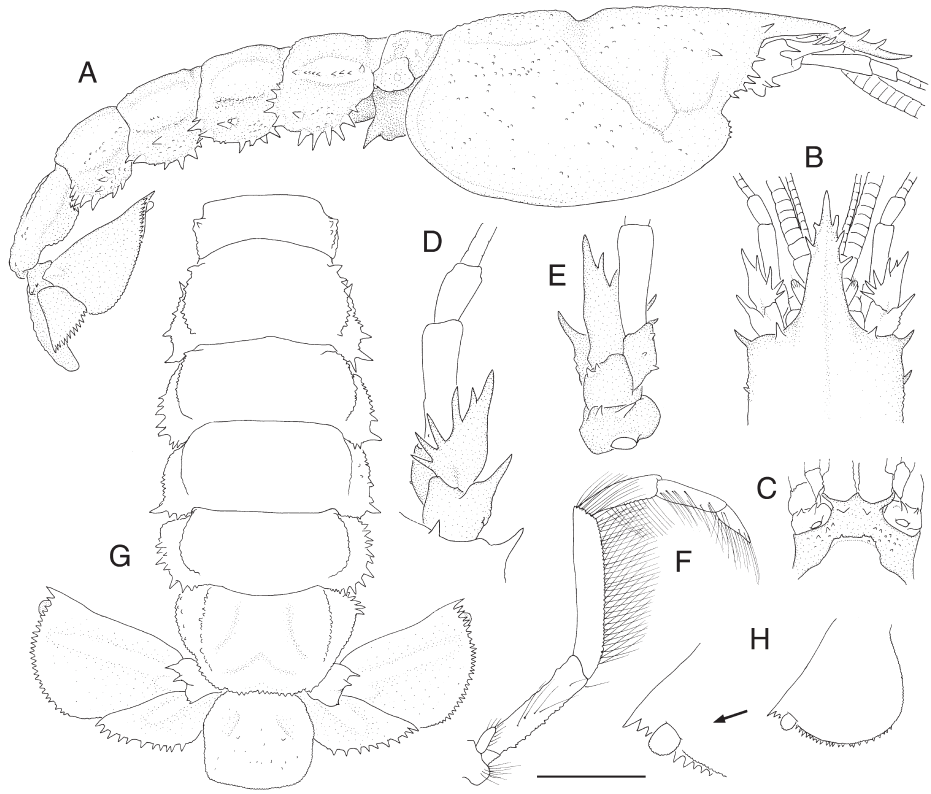

Figure 1. *Thaumastochelopsis brucei* sp. nov., holotype male (cl 21.1 mm), AM P49083, east of Swains Reef, Queensland. (A) body, right lateral view, (B) anterior carapace, dorsal view, (C) epistome, ventral view, (D) right antenna, dorsal view, (E) right antenna, ventral view, (F) right third maxilliped, lateral view, (G) abdomen, dorsal view, and (H) uropodal exopod, ventral view. (A–D, G: setae omitted). Scale A–C, G, H = 5 mm. D–F = 2.5 mm.

Pereopod 1 chelate, with few sparse setae; markedly unequal and dissimilar; coxae with 2 or 3 tubercles on inner margin. Major pereopod 1 ischium with irregular to tuberculate inner margin; merus with 4 spines as well as several tubercles on inner margin and 2 distal spines on outer margin; carpus with spine on outer ventral margin; propodus with palm glabrous, dorsolateral surface sparsely spinulose; pollex and dactylus with occlusal margins finely serrate, with teeth inclined anteriorly; non-occlusal margins of pollex and dactylus smooth to crenulate; dactylus with spine anterior to each articular condyle. Minor pereopod 1 ischium with spine and tubercules on inner margin; merus with tubercles and 5 widely spaced spines on inner margin and with 3 spines on outer distal margin; carpus with 3 spines on outer distal margin; propodus with outer and lower surface bearing numerous spines; dactylus with 3 proximal dorsal spines; occlusal margins of pollex and dactylus serrate (Fig. 2).

Pereopod 2 chelate, with few sparse setae; coxa with small spine and 3–5 tubercles on inner margin; basis and ischium with minutely spinose lower margin; merus with 6–8 well spaced spines on lower margin, with 1 or 2 spines on upper distal margin; carpus with unarmed upper and lower margins; propodus with unarmed upper and lower margins; pollex and dactylus with finely serrate occlusal margins.

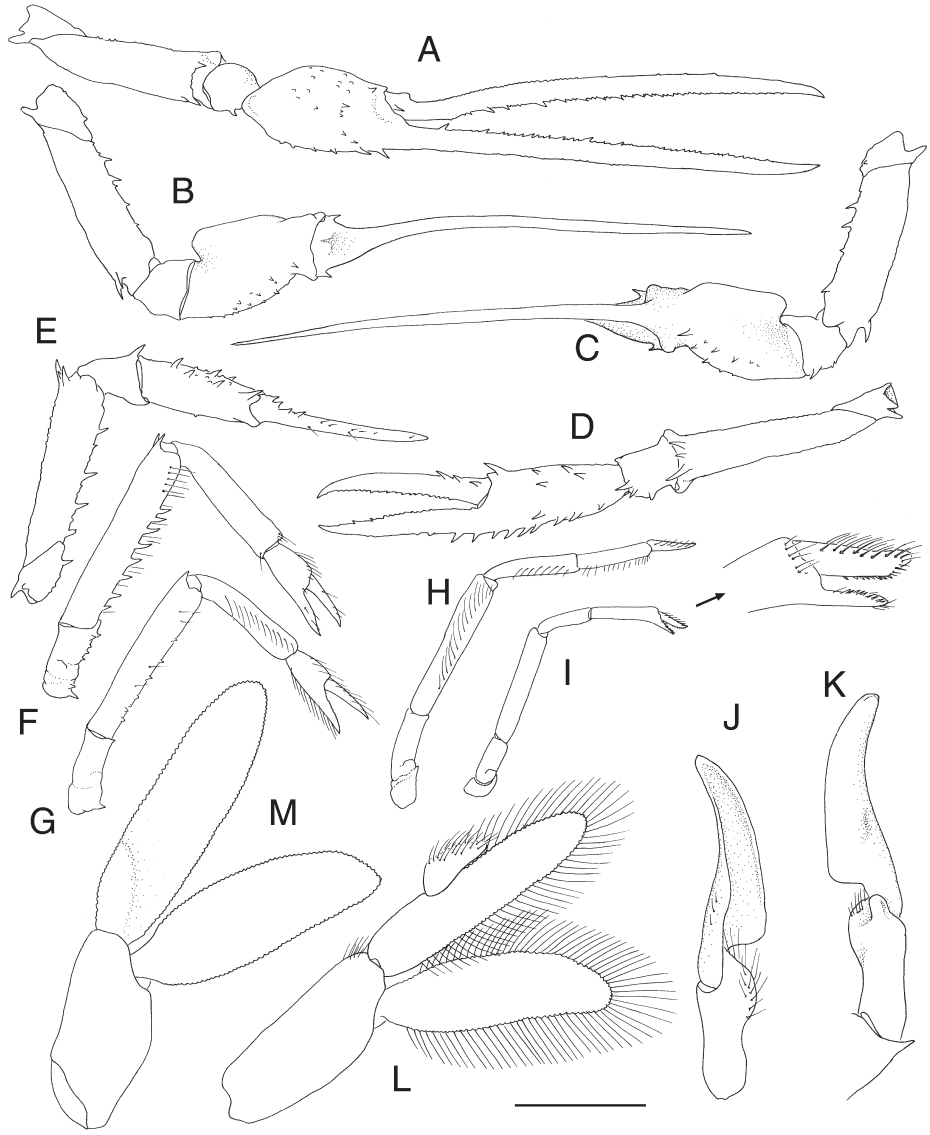

Figure 2. *Thaumastochelopsis brucei* sp. nov., holotype male (cl 21.1 mm), AM P49083, east of Swains Reef, Queensland. (A) major first cheliped, right lateral view, (B) major chela, dorsal view, (C) major chela, ventral view, (D) minor first chela, left lateral view, (E) minor first chela, dorsal view, (F) right pereopod 2, lateral view, (G) right pereopod 3, lateral view, (H) right pereopod 4, lateral view, (I) right pereopod 5, lateral view, (J) right pleopod 1, mesial view, (K) right pleopod 1, lateral view, (L) right pleopod 2, anterior view, and (M) right pleopod 3, anterior view. (A–E, M: setae omitted). Scale A–I = 5 mm. J–M = 2.5 mm.

Pereopod 3 chelate; coxa with 2 or 3 small spines and tubercles on inner margin; basis and ischium with small distal spine and few tubercles on lower margin; merus with sharp, widely spaced tubercles on lower margin, with distal spine on upper margin; carpus with unarmed upper and lower margins; propodus with unarmed upper and lower margins; pollex and dactylus with finely serrate occlusal margins.

Pereopod 4 non-chelate; coxa with 4 or 5 tubercles on inner margin; basis, ischium, merus, carpus, propodus, and dactylus unarmed; dactylus densely setose.

Pereopod 5 chelate; coxa unarmed on inner margin; basis, ischium, merus, carpus, and propodus unarmed; dactylus slightly expanded distally, setose dorsally; pollex and dactylus with stiff, obliquely directed setae on occlusal margins.

Pleopod 1 with distal and proximal segments articulating, forming copulatory organ. Proximal segment with setal field on outer distal margin. Distal segment slightly arcuate, tapering distally to rounded apex; strongly cannulate medially with proximomedial row of fine setae.

Pleopod 2 biramous; basis with posterior setal field extending to inner distal margin; exopod and endopod elongate-ovate with setose margins; exopod longer than endopod, with appendix masculina.

Pleopods 3–5 biramous; basis with posterior setal field extending to inner distal margin; exopod and endopod elongate-ovate with setose margins; exopod longer than endopod, with slight basal swelling.

Uropodal protopod short, stout, with 2 anterior spines and 1 or 2 small tubercles. Exopod proximal segment broadly trianguloid; curved distal margin lined with setae and 25–29 small closely set spines, with anterior spine largest; distal segment rounded, minute, setose, demarcated by submarginal diaeresis. Endopod markedly smaller than exopod, with posterior margin lined with 10–12 spines.

Color.—Uniform, creamy white (noted 2 wks after formalin fixation).

Etymology.—Named for A. J. Bruce, who described the genus *Thaumastochelopsis* and its type species, *T. wardi*.

Measurements.—Holotype: total length 48 mm, carapace length 21.1 mm, postorbital carapace length 14.7 mm. Paratype: total length 60 mm, carapace length 25.6 mm, postorbital carapace length 19.3 mm.

Distribution.—Known only from the central Great Barrier Reef at 199–250 m depth.

Remarks.—*Thaumastochelopsis brucei* sp. nov. closely resembles *T. wardi*, differing chiefly in the armature of the chelae. In *T. brucei*, the occlusal margins of both chelae are armed with small, anteriorly inclined serrations and small teeth, instead of the long, slender, upright teeth present in *T. wardi*. *Thaumastochelopsis brucei* further differs from *T. wardi* by bearing laterally directed pleural spines on abdominal somites 1–5, stronger spination on the lower pleural margins, long and prominent instead of short triangular spines on the margin of the uropodal protopod, stronger spination on the pterygostomial margins of the carapace, the presence of 2 or 3 instead of 1 or 2 lateral rostral spines, the presence of a distal dorsal spine on the merus of pereopod 3, more strongly tuberculate lateral carinae on the first five abdominal somites, and a straight instead of recurved ventral spine adjacent to pleopod 1. Females of *T. brucei* are presently unknown, but male *T. wardi* also bear a fixed spine adjacent to the articulation of the first pleopod, suggesting that it may be a feature of males.

The armature of the major chela in *T. brucei* closely resembles that of *Th. dochmiodon* Chan and de Saint Laurent, 1999. The two species could easily be confused if only chelae were available, as is frequently the situation with trawled, dredged material or fossils. Similarly, the armature of the major chela of *T. wardi* closely resembles that of *Th. japonicus*. The differences between *Thaumastocheles* and *Thaumastoche-*

lopsis are minor, and whether or not both genera should be recognized requires further study.

To date, nothing is known of the biology of either species of *Thaumastochelopsis*. Both species were trawled on soft substrates off eastern Queensland, and probably occupy burrows as with other nephropoids. *Thaumastochelopsis wardi* is known from 425 m whereas *T. brucei* was collected at 199–250 m depth. The two species of *Thaumastochelopsis* might have different bathymetric preferences but further research will probably show that both species probably have a wide bathymetric range. For instance, Indo-West Pacific species of *Thaumastocheles* have relatively wide bathymetric ranges: 250–822 m for *Th. dochmiodon* and 350–1110 m for *Th. japonicus* (see Chan and de Saint Laurent, 1999).

Key to Extant Species of Thaumastochelidae

1a. Eyestalk movable, distinct. Maxillipeds 2–3 with vestigial exopods. Distal segment of uropodal exopod narrow, rounded ..... (*Thaumastochelopsis*) 2

1b. Eyestalk fixed, obsolete. Maxillipeds 2–3 with well-developed exopods. Distal segment of uropodal exopod wide and short ..... (*Thaumastocheles*) 3

2a. Occlusal margins of pollex and dactylus of pereopod 1 lined with short, serrated, anteriorly inclined teeth ..... *Thaumastochelopsis brucei*

2b. Occlusal margins of pollex and dactylus of pereopod 1 lined with long, upright spines..... ..... *Thaumastochelopsis wardi*

3a. Occlusal margins of pollex and dactylus of pereopod 1 lined with short, serrated, anteriorly inclined teeth ..... *Thaumastocheles dochmiodon*

3b. Occlusal margins of pollex and dactylus of pereopod 1 lined with long, upright spines..... 4

4a. Teeth on occlusal margin of fingers of major cheliped in single row, oriented in the same plane ..... *Thaumastocheles japonicus*

4b. Teeth on occlusal margin of fingers of major cheliped in two rows, oriented in separate diverging planes ..... *Thaumastocheles zaleucus*

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